



# Project Summary

US Army Engineer  
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Waterways Experiment Station

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## Nonlinear Dynamic Response and Failure Mechanisms of Intake Towers

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**Purpose:** Develop experimentally validated analysis procedures accounting for available ductility of existing intake towers.

### Background:

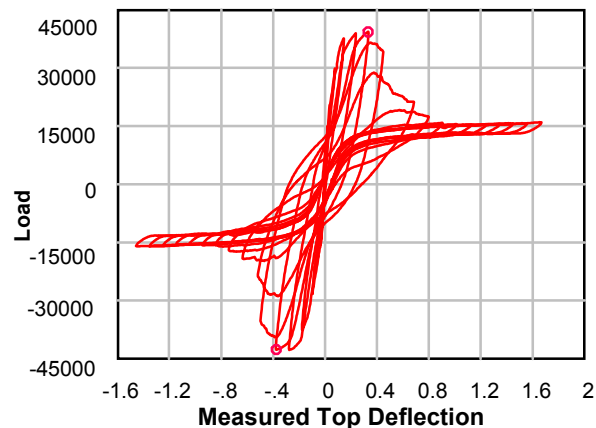
Existing Corps intake towers are lightly reinforced structures with unknown ductility and undetermined failure mechanisms. 72 Towers have been identified as being located in seismic zone 2 or above. Retrofit estimated to be between \$5 million and \$100 million per tower. Prior guidance (EC 1110-2-285) assumes incorrect multi-crack failure mechanism and does not apply to majority of Corp's tower inventory. Displacement-Based analysis procedure is suggested as alternative.



Gathright Tower

### Experimental/Analytical Results:

Experimentation has included cyclic loading of three 1/8th and fourteen 1/2 scale structural specimens with a massive amount of data generated, including load, strain, and deflection measurements. Results show substantial ductility available in existing lightly reinforced intake towers. Statistical analysis of the experimental results has produced the empirical relationships needed for modification of the deflection-based analysis procedure. The deflection-based analysis procedure has been modified to model the localized response of lightly reinforced intake towers. The modified deflection-based analysis procedure has been applied to the Lake Wappapello intake tower to demonstrate the technique. Further static and dynamic experimentation will validate procedure. Current guidance is being modified to incorporate the validated Displacement-Based analysis procedure.



### Final Product:

Design and retrofit guidance incorporating analysis procedures, with potential for substantial savings in avoided retrofit costs.